DOCKET NO.: EN9-98-122US3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Farquhar *et al.*

Serial No.: 09/781,730

Filed: 02/12/2001

Examiner: Goff II, John L.

Art Unit: 1733

Title: SEMICONDUCTOR DEVICE HAVING A THERMOSET-CONTAINING
DIELECTRIC MATERIAL AND METHODS FOR FABRICATING THE SAME

APPENDIX A

Pages 392-393 From

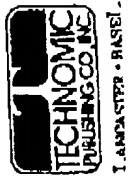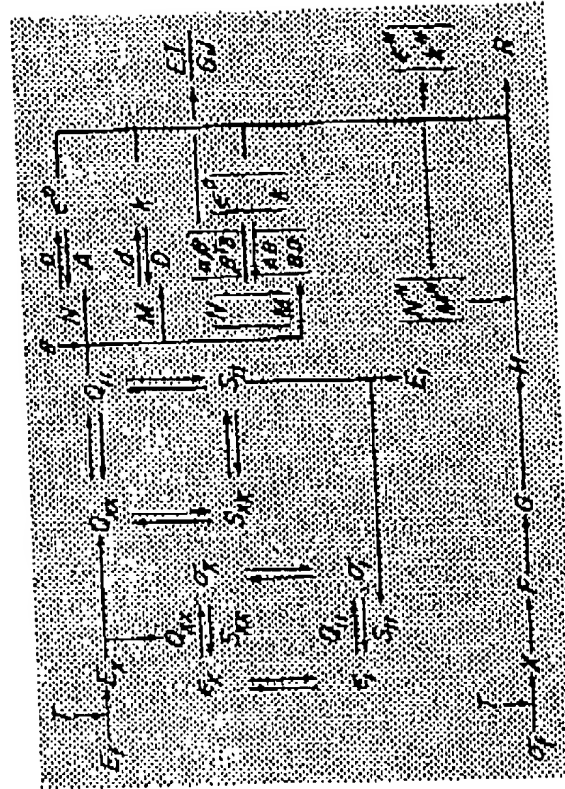"INTRODUCTION TO COMPOSITE MATERIALS"

by S.W. Tsai and H.T. Hahn

09/781,730

18

INTRODUCTION TO
COMPOSITE MATERIALS

Stephen W. Tsai
U.S. Air Force Materials Laboratory

H. Thomas Hahn
Washington University
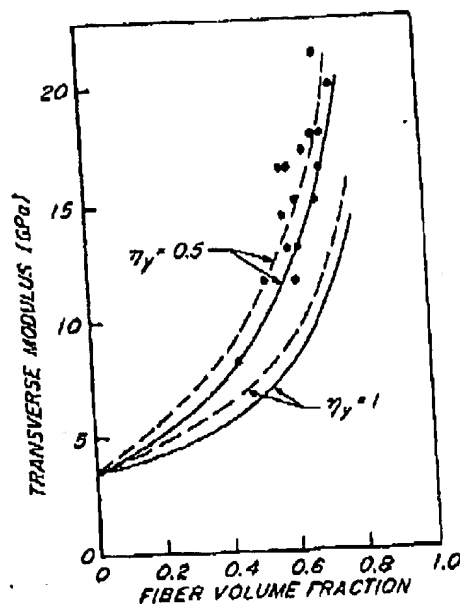
392 Introduction to composite materials

Figure 9.5 Transverse modulus versus fiber
volume fraction for a glass/epoxy composite.
The solid lines represent Equation 9.49, and
the broken lines Equation 9.45. Equation 9.45
can be modified to include η_y, and Equation
9.39 is represented by the solid line with $\eta_y = 1$.
The elastic moduli used are: $E_f = 73.1$ GPa, E_m
$= 3.45$ GPa, $\nu_f = 0.22$ and $\nu_m = 0.35$. (Data
from [1]).

yields a higher modulus than Equation 9.39. However, both predictions
are considerably lower than the data. A simplistic method of correcting
for such discrepancy is discussed in the next section.

5. modified rule-of-mixtures equations
for transverse and shear moduli

In the preceding section the representative volume element consisted of
two plates of the same thickness, each representing a fiber and matrix,
respectively. However, in actual composites, fibers are completely
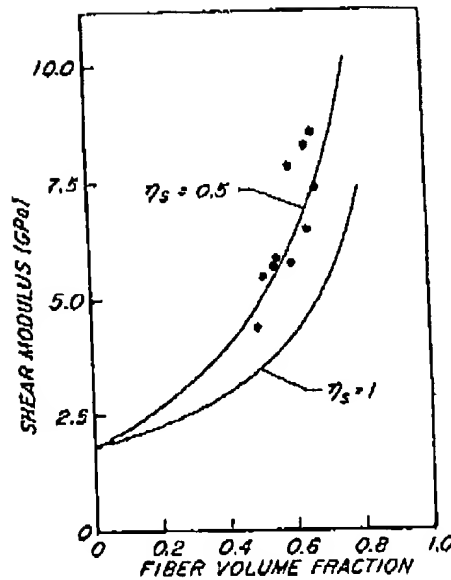
micromochanico 393

Figure 9.6 Shear modulus versus fiber volume fraction for a glass/epoxy composite. The solid lines represent Equation 9.49, and $\eta_s = 1$ corresponds to Equation 9.41. The shear moduli used are: $G_f = 30.2$ GPa and $G_m = 1.8$ GPa. (Data from [2]).

surrounded by the matrix. Thus a more realistic representative volume element will be a concentric cylinder as shown in Figure 9.7. Also, the boundary conditions should be changed to simulate the in situ state of stress the new representative volume element would be in. The exact determination of stresses is rather complicated and is beyond the scope of this book. Therefore, in the following we shall describe a semi-empirical approach to provide better estimates of moduli than the simple rule-of-mixtures equations can.

Noting that matrix is softer than fiber, we assume that

$$\breve{\sigma}_{my} = \eta_y \bar{\sigma}_{fy}, \quad 0 < \eta_y \leqslant 1$$

$$\breve{\sigma}_{ms} = \eta_s \bar{\sigma}_{fs}, \quad 0 < \eta_s \leqslant 1$$

$$(9.48)$$